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## ORIGINAL ARTICLE

# The use of synthetic mesh in patients undergoing ventral hernia repair during colorectal resection: Risk of infection and recurrence

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**Summary** *Background/Objective:* The aim was to evaluate the risk of infection and hernia recurrence for patients undergoing repair of ventral hernia (VH) with prosthetic mesh during colorectal resection.

*Methods:* A retrospective review was performed of long-term outcomes for 40 patients who underwent mesh repair for VH during bowel resection between 2000 and 2007. Patients with recurrence (R) were compared with others (NR) and univariate and multivariate analysis of factors associated with recurrence and infection were determined.

*Results:* Forty patients (60% male, mean age 61 years) with colorectal cancer, diverticulitis and inflammatory bowel disease underwent repair with non-absorbable mesh. During the course of follow-up medical visits (median follow-up of 3.0 years; 25th percentile, 75th percentile: 1.8 years, 4.6 years), mesh infection rate was 22.5% and hernia recurrence rate 40%. R ( $n = 16$ ) and NR ( $n = 24$ ) had similar age, gender, body mass index, steroid use, smoking history, and drain use. A significantly greater proportion of R had diabetes ( $p = 0.04$ ), larger fascial defect ( $p = 0.02$ ), emergency surgery ( $p = 0.001$ ), and wound infection ( $p = 0.001$ ). On multivariate analysis, duration of follow-up ( $p = 0.001$ ), comorbidity ( $p = 0.02$ ), large defect size ( $p = 0.04$ ), emergency surgery ( $p = 0.001$ ) and development of infection ( $p = 0.001$ ) were the only factors independently associated with recurrence.

*Conclusions:* Use of non-absorbable mesh during colorectal resection should be very selective. Comorbidity, duration of follow-up, emergency operations, size of area covered and infection are independent factors associated with recurrence.

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## 1. Introduction

The presence of ventral hernias, requiring repair, in patients presenting for colon or rectal operations is not infrequent considering the 2–11% incidence of incisional hernias following abdominal surgery.<sup>1,2</sup> For ventral hernias (VH), repair with mesh is considered to be the standard treatment, with a 3–17% reported recurrence rate.<sup>1,2</sup> These reports are largely based on general surgical operations and the rates for the colorectal surgical cases are not truly known and could well be underestimated. Whether the use of mesh during colorectal resection is safe is also worth assessment because concerns about the risk of wound infection and subsequent need for mesh excision currently deters surgeons from the routine use of mesh to repair ventral hernias during colorectal resection.<sup>1,3</sup> Herein we evaluate the risk of infection and hernia recurrence after repair with non-absorbable mesh in patients undergoing colorectal operations, which are traditionally classified as clean contaminated or dirty procedures; and we evaluate long term outcomes for these patients.

## 2. Methods

After approval by Suez Canal University Hospital Ethical Committee Board, a retrospective review was performed of outcomes of all patients who underwent non-absorbable mesh repair for ventral hernias in the Department of General Surgery at our institution between December 2000 and August 2007. Data relating to the type and size of mesh used was collected. A retrospective review of charts of all patients was performed.

Only patients who underwent VH repair during a colectomy procedure with a bowel anastomosis were included in the study. All patients in this study underwent the onlay mesh repair technique. Patients without bowel resection and those with the sole finding of a parastomal hernia were excluded. Patient demographics, medical and surgical history, size of fascial defect, use of drain, type of mesh used, and surgical technique used, were reviewed. Post-operative morbidity was reviewed from charts and records maintained during medical visits at our institution. In order to identify factors that might be associated with recurrence, patients who developed a recurrence (R) were compared with those that did not (NR). The frequency of deep-seated mesh associated infections manifested by the development of a tender swelling or abscess associated with a discharging fistula requiring drainage or mesh excision was also determined.

In order to obtain additional information pertaining to the need for mesh excision and recurrence, over the long term, patients were contacted via telephone interviews to determine episodes of infection and recurrence of the hernia detected by the patients and confirmed by a physician at a recent visit.

### 2.1. Statistical analysis

Summaries of quantitative data are in the form mean  $\pm$  standard deviation (SD), medians, 25th and 75th

percentiles for continuous factors. Summaries of categorical data are in the form frequency (%), using chi-square or the Fisher exact tests. An association between study variables and the likelihood of recurrence was assessed using logistic regression to produce odds ratios (OR) with 95% confidence intervals. Exact time of recurrence was not determined in all cases, so adjustment for patient follow-up time was performed through covariate adjustment in the logistic regression rather than through time-to-event analyses. Multivariable models for recurrence and infection were constructed using variables for which covariate adjustments were needed.

## 3. Results

Forty patients met the inclusion criteria, 24 patients (60%) were male, and the mean age of the patients was 61 (SD 12.5) years. Median body mass index (BMI) was 29 kg/m<sup>2</sup> (25th percentile, 75th percentile: 26 kg/m<sup>2</sup>, 33 kg/m<sup>2</sup>). Diagnoses included colorectal cancer ( $n = 25$ ), diverticulitis ( $n = 10$ ), ulcerative colitis ( $n = 3$ ) and Crohn ( $n = 2$ ). Prolene mesh was used in all patients. Median follow-up was 3.0 years (25th percentile, 75th percentile: 1.8 years, 4.6 years). Overall wound infection rate was 22.5% and recurrence rate 40% over the period of follow-up. Thirty-four patients underwent elective surgery and six patients underwent emergency surgery. After elective surgery, hernia recurrence occurred in 11 (32.4%) patients, while after emergency surgery recurrence occurred in five (83.3%) patients ( $p = 0.001$ ).

### 3.1. Comparison between R and NR groups (Table 1)

Patients with a recurrence ( $n = 16$ ) and those without a recurrence ( $n = 24$ ) had similar age ( $p = 0.9$ ), gender ( $p = 0.3$ ) and BMI ( $p = 0.8$ ). The two groups were also comparable with regards to readmission rate ( $p = 0.4$ ), perioperative steroid use ( $p = 0.15$ ) and use of drains ( $p = 0.9$ ). A significantly greater proportion of R had diabetes ( $p = 0.04$ ), and emergency surgery ( $p = 0.001$ ) when compared with NR. There was no significant difference between the two groups for renal ( $p = 0.1$ ), hypertension ( $p = 0.09$ ), pulmonary ( $p = 0.8$ ), or cardiac comorbidities ( $p = 0.4$ ) and history of smoking ( $p = 0.5$ ). As might be expected, the size of the fascial defect in R patients was significantly larger than for NR (mean length:  $11.6 \pm 5.5$  cm; mean width:  $8.9 \pm 5.1$  cm) ( $p = 0.02$ ). Patients who developed a recurrence were more likely to have developed a wound infection at surgery ( $p = 0.001$ ). A significant proportion of patients who developed a recurrence underwent emergency surgery ( $n = 5$ , 31.3%) when compared with those who did not develop a recurrence ( $n = 1$ , 6.3%,  $p = 0.001$ ). Of 19 (47.5%) patients who had a drain placed, 8/19 (42%) developed a recurrence. The use of a drain was not associated with the development of recurrence ( $p = 0.9$ ).

Nine patients (22.5%) developed a mesh infection during the period of follow-up, six of them followed by hernia recurrence after surgery. Five of these patients (55.6%) required readmission for excision of the mesh.

**Table 1** Patient characteristics.

Variable	Recurrence		<i>p</i> value
	No <i>n</i> = 24 (60%)	Yes <i>n</i> = 16 (40%)	
Age	61.2 ± 12.5	61.6 ± 12.9	0.9
Gender			
Male	13 (54.2%)	11 (68.8%)	0.3
Female	10 (41.7%)	6 (37.5%)	
Body mass index	29.5 ± 6.3	29.9 ± 5.4	0.8
Comorbidity			
Hypertension	7 (29.2%)	9 (56.2%)	0.09
Diabetes	3 (12.5%)	6 (37.5%)	0.04 <sup>a</sup>
Renal	1 (4.2%)	2 (12.5%)	0.14
Pulmonary	7 (29.2%)	4 (25%)	0.8
Cardiac	7 (29.2%)	5 (31.3%)	0.4
Any comorbidity	13 (54.2%)	12 (75%)	0.017
Fascial defect (mean area, cm <sup>2</sup> )	94.5 ± 82.1	155.5 ± 124.9	0.02 <sup>a</sup>
Perioperative steroid use	2 (8.3%)	3 (18.8%)	0.15
Smoking history	7 (29.2%)	4 (25%)	0.5
Infection	3 (12.5%)	6 (37.5%)	0.02 <sup>a</sup>
Re-admission	4 (16.7%)	5 (31.3%)	0.4
Drains	11 (45.8%)	8 (50%)	0.9
Emergency operation	1 (4.2%)	5 (31.3%)	0.001 <sup>a</sup>

<sup>a</sup> Indicates significant difference.

### 3.2. Long-term outcomes

Twenty-six patients (65%) were successfully contacted by telephone. Results for the remaining patients were not available owing to change of address, death, migration to another country or refusal to participate. Median time of follow-up for the 26 patients from the date of operation to date of telephone interview was 3.0 years (25th percentile, 75th percentile: 1.8 years, 4.6 years). Three out of the nine patients with mesh infection reported delayed mesh infection 5–17 months after surgery during the follow-up. One of them experienced many episodes of infections followed by mesh excision whereas the other two were treated conservatively. Five of the patients contacted had hernia recurrence diagnosed by a surgeon and were included in the total number of recurrences (*n* = 16).

### 3.3. Multivariate analysis of risk factors associated with recurrence (Table 2)

A multivariate analysis of factors associated with recurrence and controlling for age, smoking status, and steroid

use revealed that recurrence was associated with the presence of any comorbidity (*p* = 0.018, OR 4.27), large defect size (*p* = 0.042, OR 1.46), occurrence of infection (*p* < 0.001) and emergency surgery (*p* = 0.001, OR 12.6).

## 4. Discussion

The incidence of hernia in a laparotomy incision has been reported to range between 0.5% and 15% in clean, uncomplicated cases.<sup>4–7</sup> The risk of developing a hernia at any site is believed to be even higher when surgery is performed in the setting of a contaminated operative field, seroma, frank wound infection, preoperative radiation, steroid use and comorbidity such as malnutrition, diabetes, obesity, ulcerative colitis, Crohn's disease, and cancer.<sup>5,8</sup> The use of mesh is thought to permit a reduction in the tension developed on fascial sutures placed for repair of hernias especially where there is significant separation or frank loss of fascia. Synthetic mesh has been used for a long time for the repair of hernias in selected cases.

The risk of associated wound infection during elective or emergency colorectal surgery may deter surgeons from using

**Table 2** Multivariable logistic regression model for recurrence of ventral hernia.

Variable	Parameter estimate	Standard error	Odds ratio (95% CI)	Wald <i>p</i> value
Follow-up (y) <sup>a</sup>	0.22	0.07	1.3 (1.1–1.4)	0.001
Any comorbidity	1.32	0.57	3.8 (1.2–11.4)	0.02
Emergency surgery	0.94	0.69	12.6 (2.26–70.7)	0.001
Area covered <sup>b</sup>	0.21	0.18	1.5 (1.01–2.10)	0.042
Infection	1.49	0.90	7.9 (2.1–29.9)	0.001

<sup>a</sup> Parameter estimate and odds ratio relative to a 1 year difference.

<sup>b</sup> Parameter estimate and odds ratio relative to a doubling in area covered (through use of log 2 (area) as the model variable).

a mesh for the repair of primary or recurrent ventral hernia, possibly increasing the risk of recurrence.<sup>1,2</sup> Wound infections have been reported to occur in 2% to 35% of patients after colon resection, the likelihood of infection being greater in the case of an emergency procedure.<sup>9,10</sup> The incidence of mesh related wound infection is reported variably<sup>1</sup> and may be as high as 100%.<sup>2</sup> In the absence of contamination, the infection rate reported for mesh repair of hernias is 0.8–10%.<sup>11</sup> Therefore, it is understandable that the use of mesh in potentially contaminated wounds has been strongly discouraged. This view seems to be supported by anecdotal reports of high rates of infection and increased morbidity in this setting. However, there is a lack of data evaluating long term outcomes for patients undergoing the procedure.<sup>1,2</sup> Although some authors have suggested abandoning the use of mesh for repairs in which open bowel is present or encountered and in contaminated fields,<sup>1,4,8–13</sup> some recent series question this consensus. Vix et al<sup>14</sup> reported that non-absorbable mesh could be used safely for hernia repair in a contaminated field if placed in the retro-muscular prefascial plane.

This study has sought to contribute to the debate concerning the safety and efficacy of mesh repair of incisional hernias in the contaminated operative field and to expand the scope of this important discussion. As these patients were evaluated at our institution over a median follow-up of 3 years, we were able to accurately determine the risk of infection and recurrence over a prolonged period.

In our study, the recurrence rate for all patients undergoing ventral hernia repair during colorectal resection was 40% and wound infection rate was 22.5%. For the 34 patients who underwent elective surgery, the hernia recurred in 11 patients (32.4%) after a median follow-up of 2.5 years as determined at medical visits. When data from telephone interviews were obtained, the recurrence rate was 40% and infection rate was 22.5% over a median follow-up of 3.0 years.

As the preference at our institution is to avoid the use of mesh unless adequate tissue approximation is not possible with sutures placed during abdominal wall closure, the high rate of recurrence of the hernia in the patients on follow-up might be a reflection of the selective use of mesh in complex procedures associated with significant abdominal wall defects. A greater proportion of patients who developed a recurrence had an emergency procedure, a larger sized fascial defect and wound infection when compared with those who did not develop a recurrence. Recurrence was also associated with comorbid disease conditions such as diabetes, and hypertension. Diagnosis, i.e., inflammatory bowel disease or cancer, was not significantly associated with the development of recurrence of hernia.

Emergency surgery can be expected to be associated with a greater risk of recurrence as patients are expected to be in a suboptimal clinical state when compared with those undergoing elective surgery. Previous studies have reported that the presence of one or more comorbidities predispose patients to development of hernia recurrence.<sup>3</sup> An association between hypertension and diabetes mellitus and poor wound healing and the development of mesh infection has been described.<sup>15,16</sup> A greater proportion of patients in our study who developed a recurrence had these comorbidities thus suggesting that impaired wound healing in these patients might have been contributory.

A body mass index of over 30 kg/m<sup>2</sup> has been described as a known risk factor for the development of ventral hernia owing to delayed wound healing, an impaired pulmonary function and a high intra-abdominal pressure<sup>3,17</sup> but these comorbidities are not an absolute contraindication to the use of mesh.<sup>17</sup> In our group of patients, the majority were overweight with almost half being considered obese. There was no significant difference in the proportion of obese patients in the R and NR groups.

The strength of this study lies in the fact that outcomes are reported for a large number of patients undergoing repair of ventral hernia with non-absorbable mesh during colorectal resection. Although outcomes pertaining to mesh infection and recurrence were retrospectively derived, with all the associated drawbacks of underestimation, these data were obtained by a careful scrutiny of records of patients who continued with evaluation in the office at our institution and are therefore likely to be accurate. The response rate in this study was 65% and this is consistent with typical response rates found in the literature which range between 40–60%.<sup>18</sup> In order to reduce the risk of under-reporting the frequency of these outcomes, patients were also contacted over the telephone, as some patients might have developed mesh infection or recurrence several years after their last medical visit. The finding that the infection rate for non-absorbable mesh was 22.5% even in this select group of patients undergoing complex operations, suggests that the use of non-absorbable mesh during elective colorectal resection can be acceptable in selected cases.

## 5. Conclusions

Frequency of mesh infection with the use of non-absorbable mesh during elective colorectal resection in selective patients is comparable to that during isolated ventral hernia repair with mesh. Comorbidity, duration of follow-up, emergency operations, size of area covered and infection are independent factors associated with recurrence.

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